Extra Credit 1

CMSY-199, Fall 2012

50 points

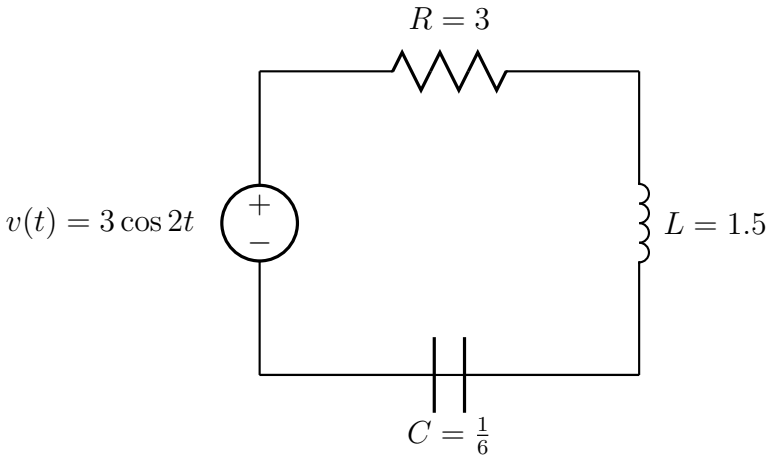
The source code and sample output for this assignment must be submitted by email prior to the start of class on Monday, November 19.

A common application of complex numbers in the field of Electrical Engineering involves converting a real-valued AC Circuit into a complex-valued Phasor Circuit. The Phasor Circuit *greatly* simplifies the solution of the AC Circuit although it does require the manipulation of complex numbers rather than real numbers.

1. Write a class called `PhasorCircuit` which *has* two member variables:
   (a) a double named `frequency`
   (b) a three-element array of type Complex named `impedance`
2. Write a constructor that takes four doubles named `w`, `R`, `L`, and `C`. Assign the argument `w` to the member variable `frequency`. Use the formulas shown in the Phasor Circuit for $\mathbf{Z_R}$, $\mathbf{Z_L}$, and $\mathbf{Z_C}$ to initialize the Complex member variables `impedance[0]`, `impedance[1]`, and `impedance[2]` from the arguments.
3. Write a method called `solveCurrent` which takes an argument of type Complex named `phasorVoltage` and returns a Complex type. Use equation (2) below to compute and return the phasor current, $\mathbf{X}$.
4. Make the `PhasorCircuit` class a Java application by adding a `main` method to:
   (a) Create an instance of type `PhasorCircuit` called `seriesCircuit` using the parameters ω, R, L, and C shown in the AC Circuit below. *Hint:* be careful not to perform integer division when computing C.
   (b) Create an instance of type Complex called `phasorVoltage` with the value of the phasor voltage, $\mathbf{V}$, in the Phasor Circuit below.
   (c) Print the phasor current by calling the `solveCurrent` method of the `seriesCircuit` object with `phasorVoltage` as the argument.

AC Circuit

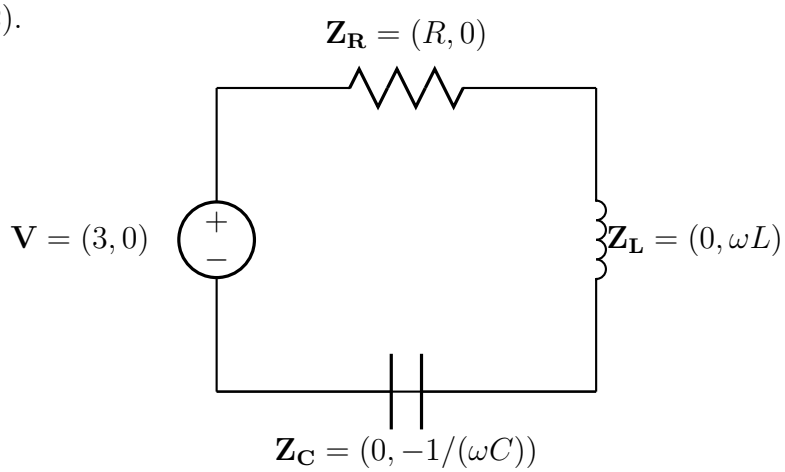
An AC Circuit with an ideal voltage source of $v(t) = 3\cos 2t$ volts is connected in series to three circuit elements - one $R = 3$ ohm resistor, one $L = 1.5$ henry inductor, and one $C = \frac{1}{6}$ farad capacitor. Note that the frequency of the voltage source is $\omega = 2$ radians/s. The resulting current, $x(t)$ amperes, is given by the differential equation (1).



$$\frac{\mathrm{d}^2x(t)}{\mathrm{d}t^2} + \frac{R}{L}\frac{\mathrm{d}x(t)}{\mathrm{d}t} + \frac{1}{LC}x(t) = \frac{1}{L}\frac{\mathrm{d}v(t)}{\mathrm{d}t} \tag{1}$$

Phasor Circuit

The corresponding Phasor Circuit has phasor voltage $\mathbf{V} = (3, 0)$, resistor impedance $\mathbf{Z_R} = (R, 0)$ ohms, inductor impedance $\mathbf{Z_L} = (0, \omega L)$ ohms, and capacitor impedance $\mathbf{Z_C} = (0, -1/(\omega C))$ ohms. The resulting phasor current, $\mathbf{X}$ amperes, is given by the algebraic equation(2).



$$\mathbf{X} = \frac{\mathbf{V}}{\mathbf{Z_R} + \mathbf{Z_L} + \mathbf{Z_C}} \tag{2}$$

After solving for the phasor current, the current in the original AC circuit is given by equation (3).

$$x(t) = \mathrm{Re}[\mathbf{X} \cdot (\cos 2t, \sin 2t)] \tag{3}$$